Canadian Centre for Occupational Health and Safety

Centre canadien d'hygiène et de sécurité au travail

HEALTH HAZARDS OF RADIATION FROM VIDEO DISPLAY TERMINALS

Questions and Answers

P88-15E

88-05673/

HEALTH HAZARDS OF RADIATION FROM VIDEO DISPLAY TERMINALS

Questions and Answers

David Charron

Canadian Centre for Occupational Health and Safety

July 1988

CCOHS/CCHST

HEALTH HAZARDS OF RADIATION FROM VIDEO DISPLAY TERMINALS--QUESTIONS AND ANSWERS

Each publication produced by CCOHS undergoes several stages of review. As a part of this review, representatives from government, employers, and labour are requested to comment on draft copies of CCOHS publications for technical accuracy and readability.

Although every effort is made to ensure accuracy and completeness of the information, it is understood that CCOHS makes no warranty as to the accuracy or completeness of such information and assumes no liability for any damages or loss suffered as a result of any inaccuracy or incompleteness therein.

This publication is available in both official languages.

Cette publication est disponible dans les deux langues officielles.

CCOHS NUMBER P88-15E
ISBN 0-660-12965-5
DSS CATALOGUE NUMBER CC273-2/88-15E

Published 1988

---

250 Main Street East
Hamilton Ontario
L8N 1H6
416-572-2981
FAX 416-572-2206
Telex 061-8532

CCOHS/CCHST

TABLE OF CONTENTS

	PREFACE	(ii)
1.	WHAT ARE THE MAIN HEALTH ASPECTS CONCERNING THE USE OF VDTs?	1
2.	DO VDTs EMIT ELECTROMAGNETIC RADIATION?	1
3.	DO VDTs EMIT X-RAYS?	2
4.	HOW ARE THE ELECTRIC AND MAGNETIC FIELDS PRODUCED?	2
	Electrostatic Field	2
	Electric Field	2
	Magnetic Field	3
5.	DO ALL VDTs EMIT THE SAME LEVELS OF ELECTRIC AND MAGNETIC FIELDS?	3
6.	CAN VDTs CAUSE SKIN RASHES AND BLOODSHOT EYES?	4
7.	DO VDTs CAUSE BIRTH DEFECTS OR MISCARRIAGES?	4
8.	DO VDTs DAMAGE OPERATOR VISION?	5
9.	WHAT ARE THE OCCUPATIONAL EXPOSURE STANDARDS FOR VDT FIELDS?	5
10.	HOW CAN EXPOSURE TO THESE FIELDS BE REDUCED?	5
11.	HOW CAN VDTs BE SHIELDED?	6
12.	HOW SHOULD THE WORKPLACE BE ORGANIZED TO REDUCE OR AVOID EXPOSURE?	6
13.	SHOULD OPERATORS WEAR A LEAD APRON?	7
14.	HOW CAN FIELDS FROM VDTs BE MEASURED?	7
15.	HOW DOES A VDT COMPARE TO A TV SET?	7
16.	DO VDTs EMIT HARMFUL ULTRASOUND?	8
17.	HOW DO FLAT SCREEN DISPLAYS COMPARE TO REGULAR VDTs?	8
	FURTHER READING	10

CCOHS/CCHST

PREFACE

This publication provides brief answers to typical questions received by the CCOHS Inquiries Service concerning possible health hazards of electromagnetic fields from video display terminals (VDTs). The views expressed in this publication are those of CCOHS technical staff and are based on information available in the scientific literature. This topic is very controversial, as evidenced by the highly polarized comments received during external review of this document. For more information on a particular topic, you can consult the Further Reading list or contact CCOHS directly.

1. WHAT ARE THE MAIN HEALTH ASPECTS CONCERNING THE USE OF VDTs?

Concerns about VDT operation fall into the following categories:

- eye and vision problems
- muscle strain and discomfort
- stress
- skin rashes
- reproductive disorders

Concerns about radiation emissions and how they affect vision will be discussed in Question 8. Skin rashes and reproductive disorders are serious concerns and are discussed in detail. In general, vision problems can be considered a function of workplace design and will not be discussed in this document. As well, muscle strain and discomfort is an ergonomic concern and will not be discussed here. Stress experienced by VDT operators is determined by many factors, and is outside the scope of this document.

2. DO VDTs EMIT ELECTROMAGNETIC RADIATION?

VDTs, like any similar electrical appliance, can emit a wide range of electric and magnetic fields. Fields emitted by VDTs can be categorized as follows:

- direct current (DC) electrostatic field
- extremely low frequency (ELF) and very low frequency (VLF) magnetic fields
- very low frequency (VLF) pulsed electric fields

Fields from VDTs are non-ionizing; that is, they are low frequency, long wavelength and low energy electromagnetic fields that are unable to cause ionization (to remove an electron from an atom) when passing through the body. This is unlike ionizing radiation, such as X-rays, which has enough energy to break up atoms and molecules.

Measurements have shown that levels of other non-ionizing radiation, including ultraviolet, visible and infrared, are well below hazardous levels. Microwaves are not produced by VDTs.

3. DO VDTS EMIT X-RAYS?

X-rays are produced by VDTs, but measurements have shown that the exposure associated with VDT operation is negligible. Weak X-rays are produced by the picture tube (cathode ray tube) in the VDT. However, the thick leaded glass of the tube efficiently absorbs X-rays. Levels measured outside the tube are many times below levels considered dangerous.

4. HOW ARE THE ELECTRIC AND MAGNETIC FIELDS PRODUCED?

Electrostatic Field

The electrostatic field is caused by a voltage difference between the VDT screen and the VDT operator. The VDT screen (insulated to prevent electric shock) has a voltage between 1000 V (volts) and 20,000 V. The field exists in front of the screen only. Other factors which contribute to the electrostatic field include the relative humidity, the type of clothing worn by the operator, floor covering, and the type of chair covering.

Electric Field

The pulsed VLF electric field is produced by the flyback transformer (Figure 1). Measurements have shown that levels range from zero to over 300 V/m (volts per meter). The highest levels are found at the side or rear surface of the VDT, depending on the location of the flyback transformer. Levels in front of the screen at the operator's position are very low, usually under 10 V/m at 30 cm (Figure 2).

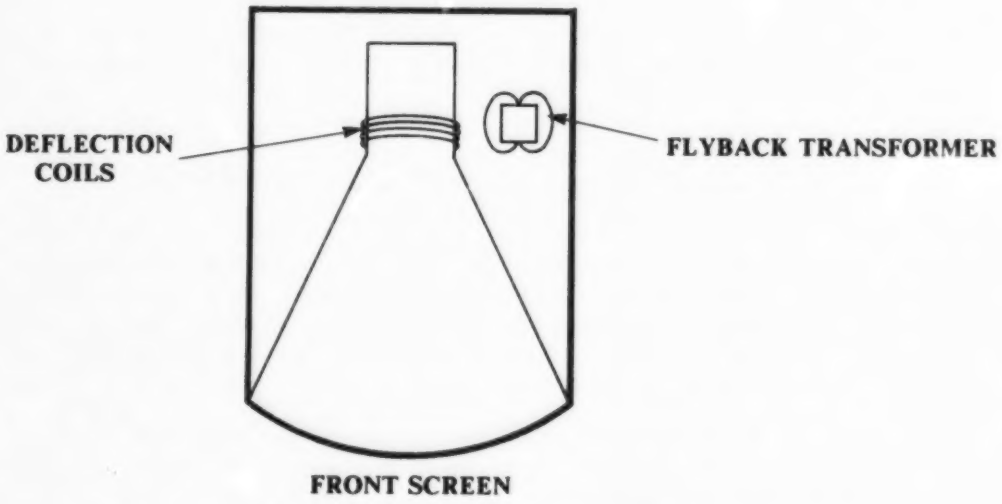

Figure 1 - Cross-section of a typical video display terminal showing one possible location of the flyback transformer

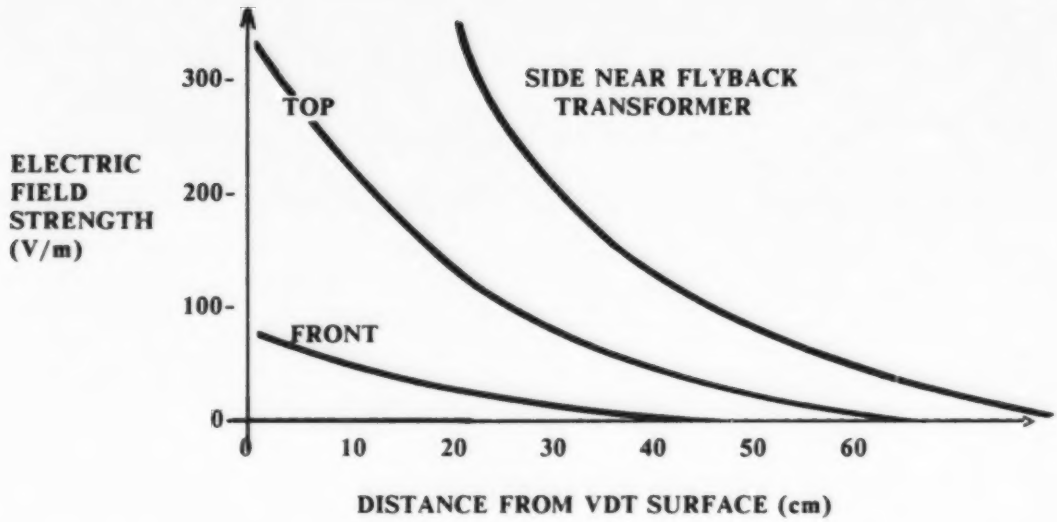

Figure 2 - Levels of VLF electric field from a typical video display terminal

Magnetic Field

Magnetic fields are emitted by the deflection coils around the neck of the picture tube (Figure 1). These coils act as electromagnets and are responsible for moving the electron beam across the face of the picture tube to form characters or pictures on the screen. The magnetic fields are created by current flowing in the coils; the more current that flows, the stronger the magnetic field.

Magnetic fields from VDTs are very weak and are evenly distributed around the VDT. This means that the magnetic field strength at 30 cm from the left side is about the same as the field strength 30 cm from the right side, rear and front of the VDT. Typical levels range from about 0.1 to 1 A/m (amperes per meter) at 30 cm from the VDT surface.

5. DO ALL VDTs EMIT THE SAME LEVELS OF ELECTRIC AND MAGNETIC FIELDS?

No, different types of VDTs may emit stronger or weaker electric and magnetic fields, depending on several factors.

Relative to small monochrome screens, larger screens generally require somewhat larger voltages and currents, resulting in higher field strengths. Colour VDTs require higher voltages, also resulting in slightly higher field strengths.

As well, there are slight design differences in VDTs which result in different field emissions. In general, units of the same make and model will have similar emissions.

6. CAN VDTs CAUSE SKIN RASHES AND BLOODSHOT EYES?

There have been reports of VDT operators suffering bloodshot eyes and skin rashes on the face and hands. It is believed that, in dry conditions, the electrostatic field between the VDT screen and the operator may cause charged airborne particles to be attracted to the operator's face and hands. If reactive enough, these particles could cause skin and eye irritation in sensitive individuals.

Other studies suggest that these complaints may be linked to a change of the ionic environment in front of the VDT, caused by the electrostatic field. The positive charge on the VDT screen may result in a reduction of negative ions in the air around the operator. Higher positive ion concentrations are believed by some scientists to cause psychological distress, fatigue and behavioural changes, but the whole question of effects of ions, positive or negative, is controversial.

7. DO VDTs CAUSE BIRTH DEFECTS OR MISCARRIAGES?

There have been reports of high rates of birth defects or miscarriages among clusters of pregnant VDT operators. However, there is no conclusive scientific evidence linking work with VDTs to adverse pregnancy outcome among VDT operators.

Experts who have examined these clusters have concluded that they could have occurred by chance. Factors which support this conclusion include the fact that a large percentage of VDT operators are women of child-bearing age, and a large percentage of all pregnancies routinely end in either miscarriage (10% to 20%) or with an infant with some birth defect (2% to 4%).

Because of the small groups involved with reported clusters, it is not possible to determine what the cause might be with any degree of certainty. One way to find an answer is by performing studies on large groups of people. These are called epidemiological studies. For investigation of VDTs, they usually consist of questionnaires given out to female VDT operators to determine information on work habits, pregnancy outcome, and other important factors like smoking and drinking habits. The information is statistically evaluated to determine if there is a link between VDT work and birth defects or miscarriages.

Most completed epidemiological studies have dismissed the possibility of a link between VDT work and birth defects or miscarriages. But a recent epidemiological study found an increased risk of miscarriage for women who work with VDTs. While this study does not prove an association between VDT work and miscarriages, it is the first study to show a statistically significant increase (see Goldhaber in the Further Reading list).

Yet, none of the studies thus far have measured actual operator exposure to electromagnetic fields. This omission weakens the validity of results from studies intended to determine if there is an association between radiation emissions from VDTs and health effects.

Exposure of laboratory animals to magnetic fields similar to those emitted by VDTs has produced controversial results. It is not yet clear whether exposure to magnetic fields is hazardous.

8. DO VDTs DAMAGE OPERATOR VISION?

Measurements of ultraviolet, visible and infrared emissions from VDTs have been reported in the health and safety literature. These emissions are over 100 times less than the recommended maximum exposure limits in North America.

But there have been reports of cataracts in VDT operators. Close examination of these cases has shown that it is highly unlikely that VDTs produced the cataracts. The scientific data indicate that none of the radiation emissions, at the levels found from VDTs, are capable of producing cataracts.

9. WHAT ARE THE OCCUPATIONAL EXPOSURE STANDARDS FOR VDT FIELDS?

Currently, there are no official standards limiting exposure to electric or magnetic fields specifically from VDTs. But there are guidelines limiting occupational exposure to electromagnetic fields covering the same frequency range as fields from VDTs (Table 1). Included in this list is a Canadian guideline which has been recently proposed. It should be noted that compliance with the guidelines does not guarantee the lack of a health hazard. The World Health Organization (WHO) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend avoiding unnecessary exposures to non-ionizing radiation, indicating that our knowledge of long-term health effects is insufficient to determine a "safe" level of exposure to low frequency electromagnetic fields.

10. HOW CAN EXPOSURE TO THESE FIELDS BE REDUCED?

Exposure to VDT fields can be avoided or reduced by two methods: shielding the source of the fields (Question 11), or reorganizing the workplace to reduce avoidable exposures (Question 12).

Table 1 - Occupational exposure guidelines

	Electric Field (V/m)	Magnetic Field (A/m)
Canada (Proposed)	280	1.8
ACGIH	614	1.63
West Germany	1500	350
US National Radiation Protection Bureau	600	--
International Trade Union Conference	5 *	--

* As measured at the surface of the VDT

11. HOW CAN VDTs BE SHIELDED?

Most VDTs are shielded by the manufacturer to reduce electromagnetic emissions that may affect sensitive electronic components. Any metal, for example aluminum or copper foil, will shield an electric field. If the metal is electrically grounded, it will be a more effective shield. For more specific information on shielding the electric field, see the Further Reading list.

A magnetic field is more difficult to shield. Special metals such as mu-metal are required, and are usually quite expensive. Also, the metal must be thick enough to be efficient, making it bulky and heavy. Therefore, shielding against the magnetic field is seldom done.

There are products available which claim to reduce the electrostatic and VLF electric fields at the front screen of the VDT. They usually consist of a transparent conductive mesh filter that is placed over the screen and connected to a grounding point on the VDT.

Some specialists argue that these filters, used as shields against the electric field, are not needed since we know that the electric field at the operator's position is very low (Question 4).

12. HOW SHOULD THE WORKPLACE BE ORGANIZED TO REDUCE OR AVOID EXPOSURE?

High levels of electric field occur at the side of a VDT near the flyback transformer. The field is negligible at the operator's position. Also, the field strength decreases rapidly with distance from the terminal (see Figure 2). Therefore, it is possible to organize VDT equipment to avoid unnecessary operator exposure from adjacent VDTs.

This can be accomplished by positioning the operator at least an arm's length (about 1m) away from the sides or rear of any nearby terminal. This approach is also recommended by a World Health Organization panel (see Marriott in the Further Reading list).

13. SHOULD OPERATORS WEAR A LEAD APRON?

Since the levels of electric or magnetic fields at the operator's position are very low, it is not recommended that VDT operators wear any kind of apron or personal protective equipment.

Lead aprons, such as those used in medical offices, protect only against penetrating X-rays. A lead apron provides no protection against electric or magnetic fields. Also, if a pregnant woman wears a heavy lead apron, it can be dangerous for the fetus because of the added pressure exerted on the abdomen.

14. HOW CAN FIELDS FROM VDTs BE MEASURED?

There are several instruments that measure electromagnetic fields from VDTs. Of most importance are an electric field sensor, a magnetic field sensor, and an instrument to measure the DC charge on the screen. Measurement techniques for some instruments can be found in the CCOHS publication P86-19E "Emissions from video display terminals and their measurement: a training manual." For a list of available instruments, contact CCOHS.

Since emissions from a VDT do not increase with the age of the unit, it is not necessary to continually monitor VDT emissions after testing has initially been done.

15. HOW DOES A VDT COMPARE TO A TV SET?

A VDT operates on the same principles as a TV set; that is, they both use a picture tube (cathode ray tube). This means that the same types of fields emitted by the VDT will be emitted by a TV set. But a TV set generally has a larger screen than a typical VDT and is usually a colour set. Larger voltages and currents are required by the TV set, and the electric and magnetic fields produced are slightly higher than those from VDTs.

Exposure to these fields will be much less for TV viewers since they are usually situated several meters away from the TV. As well, the highest field strengths for the electric field are at the side of the unit (near the flyback transformer), where TV viewers are seldom located. Therefore, typical TV viewers will not be exposed to fields of significant strength.

16. DO VDTs EMIT HARMFUL ULTRASOUND?

Ultrasound, which is high frequency sound, can be produced by the cooling fan (if one is used in a VDT). Also, ultrasound may be produced by the fly-back transformer.

The sound produced by the cooling fan is barely audible, even in a quiet office environment. The sound produced by the flyback transformer is also quite low.

Measurements have shown that the levels of ultrasound from VDTs are very low and contribute relatively little to the noise level in the office environment.

17. HOW DO FLAT SCREEN DISPLAYS COMPARE TO REGULAR VDTs?

The new flat-panel video display terminals operate on different principles from the conventional VDT. The flat-panel displays include liquid crystal (LCD), plasma (gas discharge) and electroluminescent (ELD) displays.

For further information of these types of VDTs, contact CCOHS. As well, there are flat screen cathode ray tube displays available. We do not have any information on these devices at the present time.

Table 2 - Comparison of emissions from various VDTs

Characteristic	Type of Display			
	CRT	LCD	Plasma	ELD
Operating voltage (V)	15,000-30,000	5-15	200	300-600
X-ray (1 cm from screen)	10 urem/h (max)	ND	ND	ND
Ultraviolet radiation	ND	ND	ND	ND
Electric field (V/m) (at 30 cm)	150 (max)	ND	7	--
Magnetic field (A/m) (at 30 cm)	0.018-0.83	0.0016	0.022-0.032	.040
DC voltage (V) (at screen)	1000-20,000	ND	ND	--

ND = not detected above background levels
-- = levels not available

The LCD, plasma and ELD panels do not use a picture tube, deflection coils, or a flyback transformer, so they produce little or no electric or magnetic fields. From an occupational health and safety point-of-view, the electromagnetic fields from these flat-panel displays should not present any concern.

FURTHER READING

An evaluation of radiation emissions from video display terminals. Rockville, Md.: Bureau of Radiological Health, U.S. Dept. of Health and Human Services, 1981.

Apt, C.M. Perfecting the picture. IEEE Spectrum. Vol. 22, no. 7 (1985) p. 60-66.

DeMatteo, B. Terminal shock: the health hazards of video display terminals. Toronto: NC Press Limited, 1985.

Fighting the radiation hazards of VDTs. (CLC health and safety bulletin, no. 3). Ottawa: Canadian Labour Congress, 1987.

Goldhaber, M.K. et al. The risk of miscarriage and birth defects among women who use visual display terminals during pregnancy. American Journal of Industrial Medicine. Vol. 13, no. 6 (1988) p. 695-706.

Guy, A.W. Health hazards assessment of radio frequency electromagnetic fields emitted by video display terminals. Armonk, N.Y.: IBM Office of the Director of Health and Safety, 1984.

Harvey, S.M. Electric-field exposure of persons using video display units. Bioelectromagnetics. Vol. 5, no. 1 (1984) p. 1-12.

Health effects of video display terminals: council report. Journal of American Medical Association. Vol. 257, no. 11 (1987) p. 1508-1512.

Alleged radiation risks from visual display units: a statement by the International Non-Ionizing Radiation Committee of the International Radiation Protection Association. Health Physics. Vol. 54, no. 1 (1988) p. 231-232.

Investigation of radiation emissions from video display terminals. Ottawa: Environmental Health Directorate, Health and Welfare Canada, 1983.

Work with display units 86: selected papers from the International Scientific Conference on Work with Display Units: Stockholm, Sweden, May 12-15, 1986. Editors, B. Knave et al. Amsterdam: Elsevier Science Publishers, 1987.

Marha, K. Electric and magnetic fields around VDTs: review of biological effects, standards and practical solutions for reducing levels. Hamilton, Ont.: Canadian Centre for Occupational Health and Safety, 1986.

Marha, K. VLF: very low frequency fields near VDTs and an example of their removal. Hamilton, Ont.: Canadian Centre for Occupational Health and Safety, 1983.

Marha, K. et al. The distribution of a pulsed very low frequency electric field around video display terminals. Health Physics. Vol. 49, no. 3 (1985) p. 517-521.

Marha, K. et al. Emissions from video display terminals and their measurement: a training manual. Hamilton, Ont.: Canadian Centre for Occupational Health and Safety, 1986.

Marriott, I.A. et al. Health aspects of work with visual display terminals. Journal of Occupational Medicine. Vol. 28, no. 9 (1986) p. 833-848.

Purdham, J. Adverse pregnancy outcome amongst VDT operators: the cluster phenomenon. In: Papers presented at an international meeting to examine the allegations of reproductive hazards from VDUs. London: Humane Technology, 1984. p. 27-40.

Stuchly, M.A. Proposed revision of the Canadian recommendations on radiofrequency-radiation exposure. Health Physics. Vol. 53, no. 6 (1987) p. 649-665.

VDT news: the VDT health and safety report. New York: Louis Slesin, 1984-.

Visual display terminals and workers' health. (WHO Offset Publication No. 99) Geneva: World Health Organization, 1987.